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Impact Of Farm Size On The Bidding Potential For Agricultural Land

Abstract

The size structure of farms, the control of farming, and the future of the family farm are issues that are all related to the ownership and control of a unique rural resource--land. The future complexion of the U. S. countryside is intimately tied to the ability of different economic groups to gain and maintain control of the land base. Continuation of past trends in farm enlargement and off-farm migration would vest the control of the farming community in fewer and larger operating units.

Disciplines

Agribusiness | Behavioral Economics | Business Administration, Management, and Operations |
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IMPACT OF FARM SIZE
ON THE
BIDDING POTENTIAL FOR AGRICULTURAL LAND

Duane G. Harris and Richard F. Nehring

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The size structure of farms, the control of farming, and the future of the family farm are issues that are all related to the ownership and control of a unique rural resource--land. The future complexion of the U. S. countryside is intimately tied to the ability of different economic groups to gain and maintain control of the land base. Continuation of past trends in farm enlargement and off-farm migration would vest the control of the farming community in fewer and larger operating units.

Krause and Kyle (pp. 752-755) have outlined many of the incentives for further potential increases in the incidence of large farming units: (1) production and marketing economies, (2) management expertise, (3) tax incentives, (4) nonfarm investment, (5) specialization, and (6) conglomeration. Armstrong acknowledges these incentives, but also cites potential limits or impediments that may temper the continued trend toward larger units: (1) managerial talent availability, (2) problems of coordination and supervision, (3) capital availability, (4) labor availability, and (5) risk and uncertainty.

While previous studies have identified some important aspects of the farm size and control issues, the extant literature provides no overall theoretical framework within which to incorporate these key incentives and diseconomies. The purpose of this paper is to develop a theoretical

approach that can be used to determine the relationship between land ownership and the various characteristics of existing farm size classes. It is assumed that the future ownership of land will be determined by the relative bidding potential of participants in the land market.

A theoretical model of maximum bid-price is developed in Section I and discussed in Section II. In Section III, an application of the model is made to cash-grain farms in Iowa. Finally, in Section IV, a summary and some conclusions of the study are offered.

I. Theoretical Model

The basis for the development of a theoretical model of bidding potential is provided by Pratt. In his formulation of a measure of the degree of risk aversion, he defines the bid price as the largest amount a decision maker would willingly pay to obtain a risk (p. 124). This bid price is given by the equation

$$(1) \quad u(x) = E \{u(x + z - B)\}$$

where x represents the level of assets held by the decision maker; u , his utility function; E , the expected value operator; z , the risk; and B , the bid price.¹ In this analysis, x will be interpreted as the level of net worth of the decision maker and z as a random variable denoting the value of an acre of land. The term B then represents the maximum price a decision maker would be willing to pay for that acre.

By using a Taylor expansion to expand u around x (Yamane, pp. 280-281), an approximation for the bid price can be derived from the quadratic equation

$$(2) \quad \frac{1}{2} u''(x)B^2 - [E(z)u''(x) + u'(x)]B + \frac{1}{2} \{ \sigma_z^2 + [E(z)]^2 \} u''(x) + E(z)u'(x) = 0$$

where $u'(x)$ and $u''(x)$ are the first and second derivatives of the utility function, and $E(z)$ and σ_z^2 are, respectively, the expected value and variance of the value of an acre of land.

By utilizing Pratt's measure of risk aversion (p. 125)

$$(3) \quad r(x) = - \frac{u''(x)}{u'(x)}$$

equation (3) can be rewritten as

$$(4) \quad 1/2 r(x)B^2 - [r(x)E(z) - 1]B + 1/2 r(x)\{\sigma_z^2 + [E(z)]^2\} - E(z) = 0$$

Solution of this quadratic equation gives B in terms of r(x), E(z), and σ_z^2 .

If, however, z is defined as the discounted value of future income from an acre of land and is derived from a standard perpetuity model incorporating a constant rate of growth,² the value of an acre of land can be defined as

$$(5) \quad z = \frac{y(1 - t)}{(i - g)}$$

where y represents a random before-tax income stream, t is the marginal income tax rate of the decision maker, g is the expected rate of growth of after-tax income, and i is the decision maker's discount rate for pure time preference. Then E(z) and σ_z^2 , respectively, become

$$(6) \quad E(z) = \frac{(1 - t)}{(i - g)} E(y)$$

$$(7) \quad \sigma_z^2 = \left[\frac{(1 - t)}{(i - g)} \right]^2 \sigma_y^2$$

Substituting (6) and (7) into (4), gives

$$(8) \quad 1/2 r(x)B^2 - \left\{ \frac{r(x)(1 - t)E(y)}{(i - g)} - 1 \right\} B + 1/2 r(x) \left\{ \left[\frac{(1 - t)}{(i - g)} \right]^2 [\sigma_y^2 + E(y)^2] \right\} - \frac{(1 - t)}{(i - g)} E(y) = 0$$

Now, the maximum bid price B is defined in terms of the parameters of the utility function (through the measure of the degree of risk

aversion, $r(x)$); the expected value and variance of income, $E(y)$ and σ_y^2 ; the expected rate of growth of income, g ; the marginal tax rate of the decision maker, t ; and the decision maker's rate of pure time preference, i . Specification of the values of these parameters and variables allows the calculation of the bid price for any potential purchaser of farmland.

II. Decision Maker Characteristics and the Maximum Bid Price

The values of the parameters and variables in the bid-price equation (8) are related to the characteristics, capabilities, and expectations of the decision maker. An evaluation of the influence of these parameters and variables on the maximum bid price for an acre of land can be carried out by taking the total differential of (8) and solving for the effects on B of changes in $E(y)$, σ_y^2 , x , $r(x)$, t , i , and g . Thus,

$$(9) \quad \frac{dB}{dE(y)} = \frac{(1-t)}{(i-g)} > 0$$

$$(10) \quad \frac{dB}{d\sigma_y^2} = - \frac{r(x)(1-t)^2}{2D(1-g)^2} < 0$$

$$\text{where } D = r(x) \left[B - \frac{(1-t)}{(i-g)} E(y) \right] + 1.^3$$

$$(11) \quad \frac{dB}{dx} = - \frac{r'(x)N}{D} \gtrless 0$$

where $N = \left[\sqrt{1/2} B - \sqrt{1/2} \frac{(1-t)}{(i-g)} E(y) \right]^2 + \frac{1}{2} \left[\frac{(1-t)}{(i-g)} \right]^2 \sigma_y^2$. The sign of dB/dx depends upon whether the decision maker exhibits an increasing, unchanged, or decreasing degree of risk aversion over wealth, as determined by the sign of $r'(x)$.

$$(12) \quad \frac{dB}{dr(x)} = - \frac{N}{D} < 0$$

$$(13) \quad \frac{dB}{dt} = - \left[\frac{E(y)}{(i - g)} - \frac{r(x)(1 - t)\sigma_y^2}{D(i - g)^2} \right] \gtrless 0$$

The sign of dB/dt is ambiguous because a change in the marginal tax rate influences the bid price in two ways. An increase in the marginal tax rate will (1) decrease the bid price through a reduction in expected after-tax income from an acre of land, but (2) increase the bid price through a reduction in the variability of after-tax income.

$$(14) \quad \frac{dB}{di} = - \frac{(1 - t)}{(i - g)} \left[\frac{E(y)}{(i - g)} - \frac{r(x)(1 - t)\sigma_y^2}{D(i - g)^2} \right] \gtrless 0$$

$$(15) \quad \frac{dB}{dg} = \frac{(1 - t)}{(i - g)} \left[\frac{E(y)}{(i - g)} - \frac{r(x)(1 - t)\sigma_y^2}{D(i - g)^2} \right] \gtrless 0$$

The signs of dB/di and dB/dg likewise are ambiguous without knowledge of the sizes of the parameters in the model. The effect of i and g on the bid price, however, will be of equal magnitude but opposite sign.

Interpretation of equations (9) - (15) leads to the following general results:

- (a) A ceteris paribus increase in expected before-tax income resulting from economics of scale in production or marketing, more efficient management, specialization, or conglomeration will result in a higher maximum bid price per acre.
- (b) A ceteris paribus increase in the variability of before-tax income resulting from greater degrees of operating or

financial leverage or from additional exogeneous uncertainty will result in a lower maximum bid price.

- (c) A ceteris paribus increase in the initial wealth position of the decision maker will result in a higher maximum bid price if the decision maker is decreasingly risk averse over wealth ($r'(x) < 0$). If the decision maker is increasingly risk averse ($r'(x) > 0$), an increase in the initial wealth position will result in a lower maximum bid price. If the decision maker's degree of risk aversion remains unchanged over wealth ($r'(x) = 0$), the bid price will be unaffected by an increase in the initial wealth position.
- (d) A ceteris paribus increase in the degree of risk aversion resulting from changes in the parameters of the utility function will lead to a reduction in the maximum bid price.
- (e) A ceteris paribus increase in the marginal tax rate will, under reasonable assumptions about the sizes of the parameters in the model, lead to a reduction in the maximum bid price.
- (f) A ceteris paribus increase in the decision maker's rate of pure time preference will, under reasonable assumptions about the sizes of the parameters in the model, lead to a reduction in the maximum bid price.
- (g) A ceteris paribus increase in the decision maker's expected rate of growth of after-tax income will, under reasonable assumptions about the sizes of the parameters in the model, lead to an increase in the maximum bid price.

These conditions also can be interpreted in the specific context of potential future ownership of farmland. If it can be assumed that prospective buyers in the land market are decreasingly risk averse over wealth, land will be acquired by those bidders with (1) the highest expected before-tax income per acre, (2) the lowest variability of before-tax income, (3) the largest initial wealth position, (4) the lowest degree of risk aversion, (5) the lowest marginal income tax rate, (6) the lowest rate of pure time preference, and (7) the highest expected rate of growth of after-tax income.

It is likely, however, that no bidder will have an absolute advantage in all these categories. For example, decision makers with the highest expected income per acre may also be in the highest tax bracket. The ultimate winners in the land bidding process can be identified only with numerical specification of the parameters and variables in equation (8). The next section presents a numerical application of the model to cash-grain acreage in Iowa.

III. Farm Size and Bidding Potential for Cash-Grain Acreage

To demonstrate the applicability of the theoretical model to the issues of land ownership and control, maximum bid prices were estimated for various size categories of cash-grain farms in Iowa.⁴ The size categories used were Class 0-IV farms from the 1969 Census of Agriculture. The Census indicates, for each of the classes, the total acreage, number of farms, and average size of farm. In 1969, for example, the average size of cash-grain farms in Iowa ranged from more than 1,300 acres for farms in Class 0 to 170 acres for farms in Class IV (line 1, Table 1).

Data

Various sources of data were used in an attempt to define the characteristics of the average cash-grain farmer in each size category. Estimates were necessary for $E(y)$, σ_y , t , i , g , x , and $r(x)$ for each size classification.

Expected before-tax income The expected before-tax income per acre for 1970, $E(y)$, was based on the 1969 average as derived from Census data. Expected before-tax net income attributable to ownership of an acre of land was estimated by summing the market value of all agricultural products sold and receipts from government farm programs, subtracting total farm production expenses, and dividing the result by the total number of acres in cash-grain farms (lines 4-9, Appendix). Net income figures ranged from \$39.16 per acre for Class I farms down to \$19.04 per acre for Class IV farms (line 2, Table 1). Note that economies of size resulted in increasing returns to size over

TABLE 1: 1969 SUMMARY CHARACTERISTICS OF IOWA CASH-GRAIN FARMS AND FARMERS

FARM CLASS	O	I	II	III	IV
(1) Average Farm Size (Acres)	1,307	630	390	254	170
(2) Net Income Per Acre ($E(y)$)	\$36.18	\$39.16	\$33.95	\$26.67	\$19.04
(3) Variability of Net Income (σ_y)	\$6.80	\$7.36	\$6.62	\$5.05	\$6.33
(4) Marginal Tax Rate (t)	43%	32%	28%	25%	24%
(5) Discount Rate (i)	.09082	.09082	.09082	.09082	.09082
(6) Expected Growth Rate (g)	.04387	.04387	.04387	.04387	.04387
(7) Net Worth (x)	\$234,167	\$117,489	\$99,953	\$98,568	\$47,616
(8) Measure of Risk Aversion ($r(x)$)	.00298	.00594	.00699	.00709	.01467
(9) Per-Acre Bid Price (B)	\$429	\$533	\$485	\$403	\$231

Classes IV to I. Moving from the average Class I size farm to the average Class 0 size, however, brought a reduction in net income per acre.

Income variability Variability of before-tax income per acre for each size class was estimated by using 1965-1969 time-series data obtained from Iowa Farm Business Association records. The coefficient of variation was estimated for each size class in the Farm Business record survey and applied to the average net income figure for the appropriate size class in the Census scheme to give an estimate of the standard deviation of income, σ_y , (line 3, Table 1).

Marginal tax rates Taxable income per farm was estimated to determine the appropriate marginal tax rate for each size category. Total net income, as derived earlier, was divided by number of farms to get net income per farm for each size category (line 10, Appendix). According to a study by Evenson, for Iowa farms during 1969 and 1970, taxable farm profits as reported by the Internal Revenue Service represented about 46 percent of net farm income as reported by the USDA. Application of the 46 percent adjustment to net income per farm gave per-farm taxable income from farming for each size category (line 11, Appendix).

Off-farm income for each class size was obtained from the Survey of Agricultural Finance-1970. This income includes reported receipts from all off-farm activities or sources of income, excluding government payments. Off-farm income per farm was added to taxable income from farming to get total taxable income per farm (lines 12-13, Appendix).⁵

The marginal tax rate (t) for each class size was then obtained from the Federal and Iowa tax tables. Those rates ranged from 43 percent for Class 0 farms to 24 percent for Class IV farms (line 4, Table 1).

Discount and growth rates The nominal rate of pure time preference, i , for transforming expected income, $E(y)$, into value per acre, z , was determined by estimating a risk-free rate and adding a component for risk of reduced purchasing power caused by inflation. The risk-free rate represents the compensation the decision maker requires simply for postponing consumption. The inflation premium guarantees that consumption, in real terms, can be maintained at the same level as that postponed at the time an investment is made in an acre of land.

The risk-free rate was estimated by calculating a weighted average of annual Treasury Bill rates (Federal Reserve Bulletin, various issues). The inflation premium rate was estimated by using a weighted average of annual rates of change in the Index of Prices Paid by Farmers (Agricultural Statistics, p. 458). The index chosen was that for "all commodities bought for use in production and family maintenance." To emphasize the likely importance of recent experience in the formulation of consumption plans and inflationary expectations, geometrically declining weighted averages were calculated over the 1960-1969 period for both the Treasury Bill and price index rates.

The expected rate of growth in per-acre income (and thus per-acre value), g , was estimated by using annual rates of change in average Iowa farmland values over the 1960-1969 period (Murray and Porter, p. 8).⁶ Again, to capture the likely influence of recent years'

experience on the generation of expected growth rates, a geometrically declining weighted average was used.

Because of lack of information on differences among size classes in rates of pure time preference and expected growth rates, it was assumed that those rates were the same for all groups (lines 5-6, Table 1).

Net worth The average net worth (equity) for each class of cash-grain farms was estimated from data provided by the Survey of Agricultural Finance-1970. Net worth is defined as the difference between total owned assets and total liabilities. Total assets include "owned land and buildings" and "other owned assets." Total liabilities include "real-estate debt" and "non-real estate debt." Of the four components of assets and liabilities, all but other owned assets could be obtained directly from the Finance Survey.

In estimating other owned assets, it was necessary to assume that those assets comprised, at the state level, the same proportion of owned land and buildings as at the national level where such information was available (Hottel, Reinsel and Crowley). For example, national estimates for 1970 indicate that, for Class 0 farms, other owned assets represented a value 77 percent as large as that for the value of land and buildings owned. Similar calculations for the remaining classes also were based on national relationships between other owned assets and the value of land and buildings owned. With the estimation of other owned assets, equity in owned resources (net worth) was calculated for all operators in each class size. Finally, it was assumed that the

assets of the average cash-grain farm were comparable to those of Class II farms in general.⁷ That is, the relationship between other assets owned and value of land and buildings for cash grain farms was the same as for all enterprise type Class II farms.

Unfortunately, equity levels were not directly available for cash-grain class sizes from the Finance Survey. Estimates, however, were made on the basis of the assumption that the ratio of average cash-grain equity to average equity for all farms could be extended across classes. Thus, it was assumed that, if the average cash-grain farm had twice the equity of the average equity of all farms, then the average Class II cash-grain farm would have twice the equity of the average Class II farm in general. Applying this allocation procedure to the equity figures calculated for all operators gave equity levels ranging from over \$230,000 for Class 0 cash-grain farms to less than \$50,000 for Class IV cash-grain farms (line 7, Table 1).

Degree of Risk Aversion To calculate a measure of the degree of risk aversion, $r(x)$, it was necessary to estimate a utility function for farmers. Although several studies have examined the nature of farmers' utility (Officer and Halter, Halter and Beringer, Halter and Dean, Johnson), few have reported specific estimation of the parameters of utility functions. An exception is the study of Lin, Dean, and Moore (LDM).⁸ They reported the utility functions derived for six large-scale farmers in California. Because the form and parameters of the six functions differed, and in as much as LDM found no obvious direct relationship between the utility function and the size or form of the ownership of the firm, a composite utility function was constructed.

With the three quadratic utility function cases of LDM, data points were generated over the range from \$0 to \$100,000 in order to create a composite scatter diagram between utility and monetary value.⁹ A new composite utility function was then estimated through these data points.

A simple Cobb-Douglas form was chosen for the estimation of utility as a function of wealth (x) because it avoids the problem of ranges of decreasing marginal utility. The resulting composite utility function was

$$(16) \quad u = 35.6518x^{0.3016} \quad \bar{R}^2 = .93 \quad t = 28.28$$

The value for the degree of risk aversion was obtained by solving equation (3) using the specification of the utility function in equation (16). Thus,

$$(17) \quad r(x) = 0.6984x^{-1}$$

Because of a lack of direct data for Iowa cash-grain farmers it was assumed that the composite utility function developed from the LDM data was applicable to the Iowa illustration. This requires two somewhat heroic leaps of faith--that the LDM sample was representative of California farmers and that Iowa farmers, in general, have a utility function similar to that of their California counterparts. Because this numerical example was designed to be illustrative rather than definitive, however, it was thought to be worthwhile to pursue the risk consideration on the basis of the LDM utility function.

The Cobb-Douglas utility function describes a decision maker with diminishing marginal utility over the entire range of wealth and with decreasing risk aversion over wealth. The measure of risk aversion, $r(x)$, thus decreased from .01467 to .00298 over the levels of wealth from Class IV to Class 0 respectively (line 8, Table 1).

Bid price solutions and differences

Solutions of equation (8) using the farm class characteristics given in Table 1 give a range of maximum bid prices from \$533 per acre for Class I farms to \$231 per acre for Class IV farms (line 9, Table 1).¹⁰ In order of bidding potential, the classes rank from highest to lowest as I, II, 0, III, IV. The surprising result is that the largest class size, Class 0, falls in the middle of the bidding-potential range.

To try to isolate the relative importance of the class size characteristics on the bid-price differentials between classes, bid prices were calculated by using incremental changes in characteristics. Results are shown in Table 2. For example, line 1 of Table 2 compares Classes 0 and I. Column 1 gives the bid-price as \$429.08 per acre for a decision maker with all Class 0 characteristics. Column 2 shows that the bid-price would decline \$10.09 to \$418.99 if the decision maker had all Class 0 characteristics but had the net worth of a Class I decision maker. Column 3 shows that the bid price would increase \$76.19 to \$495.18 ($\$429.08 - \$10.09 + \$76.19$) if a decision maker with Class 0 characteristics and Class I net worth also had a Class I marginal tax rate. Summing across line 1 for the 0-I classes gives the Class I bid price of \$533.40.

Interpretation of the information in Table 2 offers some general insights. If all decision makers have the same utility function, rate of pure time preference, and expected growth rate, and if the parameters and values used in the model are indeed representative of the characteristics of the various size classes, then the major sources of bid-price differentials are differences in before-tax income per acre and

TABLE 2: CLASS SIZE CHARACTERISTICS AND BID-PRICE DIFFERENTIALS

Class Comparisons	Bid Price of First Class	Source and Size of Bid-Price Differentials			
		Net Worth	Marginal Tax Rate	Before-Tax Net Income	Net Income Variability
0 - I	\$429.08	\$-10.09	\$ 76.19	\$ 43.16	\$-4.96
0 - II		-13.65	101.41	-34.20	1.99
0 - III		-13.98	121.05	-151.92	18.75
0 - IV		-39.84	107.50	-277.45	11.87
I - II	533.40	-5.93	28.55	-79.90	8.51
I - III		-6.49	49.67	-199.52	25.92
I - V		-49.61	45.94	-325.69	27.13
II - III	484.63	-0.51	18.59	-116.29	16.56
II - IV		-39.61	20.28	-241.35	7.22
III - IV	402.98	-24.68	4.40	-123.51	-28.02
IV	231.17				

differences in marginal tax rates. Differences in net worth position and income variability, however, also have some influence.

Finally, the importance of size and the degree of risk aversion can be assessed by comparing the calculated bid prices with those that would pertain to a risk-neutral decision maker. If the decision maker is risk neutral, $r(x) = 0$ and the maximum bid price in (8) would be given by

$$(18) \quad B = \frac{(1 - t)}{(i - g)} E(y)$$

Comparisons of calculated bid prices using the utility function given in equation (16) with those using any risk-neutral utility function are given in Table 3. The difference between the bid prices represents the risk premium required by the decision maker. In general, the size of the risk premium increased as the farm size declined.¹¹ Note that the bid prices for risk-neutral Class III and IV farmers are less than those for risk-averse Class 0, I, and II farmers.

TABLE 3: REQUIRED RISK PREMIUMS PER ACRE

FARM CLASS	0	I	II	III	IV
Risk-Averse Bid Price	\$429.08	\$533.40	\$484.63	\$402.98	\$231.17
Risk-Neutral Bid Price	439.25	567.17	520.64	426.04	308.21
Risk Premium	10.17	33.77	36.01	23.06	77.04

IV. Summary and Conclusions

The trend of the last two decades to larger and larger farming units has been viewed by many as a threat to the family farm. Disagreement exists as to whether that trend will continue. The analysis in this paper was based on the assumption that the future control of farming will be vested in those farmers with the greatest bidding potential for agricultural land. A theoretical model was developed to explore some of the important variables affecting that bidding potential, and a numerical example of the model was developed for cash-grain farms in Iowa.

The theoretical model was constructed to determine the maximum bid-price that would be made for an acre of land by a decision maker with a given set of characteristics, capabilities, and expectations. The variables included that have an impact on the maximum bid price are (1) before-tax net income per acre, (2) variability of income per acre, (3) initial net wealth position, (4) degree of risk aversion, (5) marginal income tax rate, (6) required rate of return on investment, and (7) expected rate of growth in land income and prices. As such, the model is capable of incorporating most arguments that are typically advanced for or against the continued growth of farming units.

The numerical example identified and estimated the average characteristics of Iowa cash-grain farmers in each of the Census farm size classes 0-IV for the year 1969. These characteristics were inserted into the model to determine the maximum 1969 bid price by the average farmer in each class. Estimated bid prices ranged from a high of \$533 per acre for Class I to a low of \$231 per acre for Class IV.

Although the results of the numerical example must be interpreted with caution, they do provide some insight. First, it seems that the largest farms may not have the greatest bidding advantage after all. A combination of higher marginal tax rate and diseconomies of size may cause Class 0 farmers to have a lower maximum bid price than either Class I or Class II farmers.

Or, interpreted differently, if Class 0 farmers are to consistently outbid smaller farmers, they must have a lower degree of risk aversion, a lower required rate of return on investment, or a higher expected growth rate for income and land prices than smaller farmers. If all farmers have the same utility function, the same required rate of return, and the same expected growth rate (as we have assumed in the model) it seems that the greatest threat to the small family farm is the larger family farm.

The results of this study are consistent with the conclusions of Krause and Kyle regarding the importance of economies of size and tax incentives in the growth of farming units. In addition, however, the results indicate that wealth position, income variability, and the degree of risk aversion are important considerations for the issues of the ownership and control of farmland. If public policy is intended to "save the family farm," it may be necessary to devise schemes to deal with all these factors.

Small farmers may be at a particular disadvantage in their attempt to bid away land from their larger neighbors. For example, even if Class III and IV farmers are risk neutral, the results of the study imply that they have lower maximum bid prices than risk-averse Class 0,

I, and II farmers. Thus, policies designed to shift the burden of risk away from small farmers, in and of themselves, may be inadequate to make those farmers competitive in the land market.

The analysis in this study points out the need for additional work at both the theoretical and empirical level. Extensions of the model could be made to treat the original level of wealth as a random variable so that the impact of diversification could be considered. This would be especially fruitful for the extension of the model to evaluate the bidding potential of nonfarm investors. In addition, at the theoretical level, more complete specifications of before-tax income could be utilized to directly evaluate the impact of economies and diseconomies of size.

The attempt to generate meaningful estimates of decision maker characteristics, capabilities, and expectations painfully demonstrated the need for additional research on farmers' utility functions, on total economies and diseconomies of size, and on the process of the generation of expectations. Hopefully, this study offers some encouraging incentives for researchers in those areas. The issues of ownership and control cannot be completely resolved until more accurate and complete specifications of the important parameters are made.

APPENDIX. CHARACTERISTICS OF IOWA CASH-GRAIN FARMS, 1969

FARM CLASS	O	I	II	III	IV
(1) Total Acres	182,912	1,544,393	2,953,671	2,447,642	1,351,603
(2) Number of Farms	140	2,452	7,579	9,630	7,973
(3) Ave. Acres Per Farm	1,307	630	390	254	170
(4) Value of Products Sold	\$19,859,629	\$134,750,779	\$209,985,512	\$138,658,901	\$58,410,801
(5) Government Payments	1,185,035	10,076,216	19,073,342	16,494,441	9,093,717
(6) Total Receipts	21,044,664	144,826,990	229,058,854	155,153,342	67,504,518
(7) Farm Production Expenses	14,426,169	84,352,607	128,772,350	89,881,333	41,765,131
(8) Net Income From Farming	6,618,495	60,474,383	100,286,504	65,272,009	25,739,387
(9) Net Income Per Acre	\$36.18	\$39.16	\$33.95	\$26.67	\$19.04
(10) Per-Farm Net Income From Farming	\$47,275	\$24,663	\$13,232	\$6,778	\$3,228
(11) Per-Farm Taxable Income From Farming (46% of (10))	21,746	11,345	6,087	3,118	1,485
(12) Per-Farm Off-Farm Income	2,330	2,807	2,813	3,833	4,610
(13) Per-Farm Total Taxable Income	24,076	14,152	8,900	6,951	6,095
(14) Marginal Income Tax Rate	43%	32%	28%	25%	24%

FOOTNOTES

1. The variables B and z are equivalent to π_b and \tilde{z} in Pratt's notation.
2. See, for example, Van Horne (pp. 21-22).
3. The sign of D is ambiguous without information about the size of $r(x)$. For the results to be consistent with risk averse behavior, however, $dB/d\sigma_y^2$ should be negative. This requires that D be positive. It was assumed that such is the case in further development of the paper.
4. Cash-grain farms were used to avoid the complications of estimating income from livestock facilities that would accompany land in diversified farming areas.
5. This procedure is based on the assumption that the benefits of deductions, exemptions, and tax management are exhausted in the 54 percent reduction of reported net income to taxable income from farming. Thus, a dollar of off-farm income was treated as an additional full dollar of taxable income.
6. For this analysis it was assumed that the simple perpetuity model with constant growth was appropriate. It is possible, of course, that the rates of growth in per-acre income and value, in the short run, will not be equal. The model, however, is not restricted to the use of the simple valuation model. If necessary, more complicated valuation relationships could be incorporated.

7. The value of land and buildings owned by cash-grain farmers was closest in value to those owned by Class II farmers in general.
8. The LDM utility function is defined over income rather than wealth. If it can be assumed, however, that wealth is a discounted series of future income streams, wealth is but a linear transformation of income. Although the parameters of the utility function over wealth will be different from those of the utility function over income, the risk function $r(x)$ will be invariant with respect to income and wealth.
9. The linear cases of LDM were eliminated since they are but a special case of equation (8), where $r(x) = 0$. Also, the cubic equation was eliminated because its data points deviated so drastically from those generated by the other risk functions. Finally, the range of monetary values was terminated at \$100,000 to avoid data points that represented decreasing marginal utility of wealth.
10. The average value of cash-grain farmland reported in the 1969 Census was \$434 per acre. In an auction system, the market price will not be equal to the maximum bid price. Theoretically, it should be one bid unit higher than the second highest maximum bid price of the participants in the auction. The difference between the maximum bid price of the purchaser and the actual purchase price represents a form of consumer surplus that accrues to the purchaser.

11. The notable exception is Class III, where the risk premium declined.

Derivation of the risk premium gives $\pi = 1/2 r[x + E(z)] \sigma_z^2$

(Pratt, p. 125) where π is the size of the risk premium. Thus, the risk premium is a function of initial net wealth, the expected value of an acre of land and the variability of the value of an acre of land. The risk premium also can be defined as

$$\pi = \frac{r[x + E(z)](1 - t)^2}{2(i-g)^2} \sigma_y^2. \text{ For Class III farms, the variance of}$$

income σ_y^2 was substantially smaller than for the other categories.

Hence, the smaller risk premium than for adjacent size classes.

REFERENCES

1. Armstrong, David L., "Can Family Farms Compete: An Economic Analysis," in Corporation Farming: What are the Issues? Proceedings of North Central Workshop, Chicago, April, 1969. Dep. Agric. Econ. Rep. 53, University of Nebraska, 1969.
2. Board of Governors of the Federal Reserve System, Federal Reserve Bulletin, Washington, D. C. (various issues).
3. Evenson, Robert E., "Notes on Farm Income Taxation," Mimeographed, New Haven: Yale University.
4. Halter, Albert N., and Christoph Beringer, "Cardinal Utility Functions and Managerial Behavior," J. Farm Econ. 42:118-132, Feb. 1960.
5. Halter, Albert N., and Gerald W. Dean, Decisions Under Uncertainty, Cincinnati, Southwestern Publishing Co., 1971.
6. Hottel, J. Bruce, Robert D. Reinsel, and Willaim D. Crowley, "Debt Status of U. S. Farm Operators and Landlords by Economic Class, 1960, 1966, 1970," Mimeographed, Washington, D. C.: U. S. Department of Agriculture, Economic Research Service, Inputs and Finance Program Area.
7. "Iowa Farm Business Association Records, Summary Data," Unpublished, Ames, Iowa: Department of Economics, Iowa State University.

8. Johnson, Paul R., "Do Farmers Hold a Preference for Risk?" J. Farm Econ. 44:200-207, Feb. 1962.
9. Krause, Kenneth R., and Leonard R. Kyle, "Economic Factors Underlying the Incidence of Large Farming Units: The Current Situation," Am. J. Agric. Econ. 52:748-761, Dec. 1970.
10. Lin, William, G. W. Dean, and C. V. Moore, "An Empirical Test of Utility vs. Profit Maximization in Agricultural Production," Am. J. Agric. Econ. 56:497-508, Aug. 1974.
11. Murray, William G., and Daniel E. Porter, "Rise in Land Values Slows to 2 Percent in 1969," Iowa Farm Sci. 24:575-577, Feb. 1970.
12. Officer, R. R. and A. N. Halter, "Utility Analysis in a Practical Setting," Am. J. Agric. Econ. 50:257-278, May 1968.
13. Pratt, John W., "Risk Aversion in the Small and in the Large," Econometrica 32:122-136, Jan.-Apr. 1964.
14. U. S. Bureau of the Census, Census of Agriculture, 1969, Volume I Area Reports, Part 16 Iowa Sec. 1. Summary Data, U. S. Government Printing Office, Washington, D. C., 1972.
15. U. S. Department of Agriculture, Agricultural Statistics 1974, U. S. Government Printing Office, Washington, D. C., 1974.
16. U. S. Department of Commerce, Bureau of the Census, "Survey of Agricultural Finance-1970," Unpublished Iowa Summary Data.

17. Van Horne, James C., Financial Management and Policy, 3rd ed., Englewood Cliffs, N. J., Prentice-Hall, Inc., 1974.
18. Yamane, Taro, Mathematics for Economists, 2nd ed., Englewood Cliffs, N. J., Prentice-Hall, Inc., 1968.